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FUNGICIDAL TREATMENTS AND SHIPPING PRACTICES

for

Controlling Decay of Sweetpotatoes During Marketing

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CAUTION

Sodium o-phenylphenate is the only chemical used in the tests reported here that has been registered for general use on sweetpotatoes being shipped to market. When it is used on sweetpotatoes, it should be used in such a way that the residue is not more than 15 parts per million of o-phenylphenol.

An experimental label has been issued for the postharvest application of Botran (2,6-dichloro-4-nitroaniline) and may be applied to sweetpotatoes under the direction of duly authorized personnel so that the residue is not more than 10 parts per million.

An experimental permit has been issued for the postharvest application of CIPC (isopropyl-N-(3-chlorophenyl) carbamate) for the prevention of sprouting of sweetpotatoes and may be applied under the direction of duly authorized personnel so that the residue is not more than 50 parts per million.

None of the other products discussed in this report have been approved by the Food and Drug Administration for use on sweetpotatoes after harvest and should not be used commercially as postharvest dips for sweetpotatoes.

If fungicides are handled, applied, or disposed of improperly, they may be injurious to humans, domestic animals, desirable plants, pollinating insects, fish, or other wildlife, and may contaminate water supplies. Use fungicides only when needed and handle them with care. Follow the directions and heed all precautions on the container label.

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PREFACE

These tests were made possible through the cooperation of:

- Bardin Bros., Wilson, N.C., Corbett Package Co., Wilmington, N.C., and Cullifer Potato Co., Bethel, N.C., who provided some of the sweetpotatoes and test loads.
- West Virginia Pulp and Paper Co., Gastonia, N.C., who provided some of the corrugated cardboard shipping boxes.
- Dow Chemical Co., Midland, Mich., Upjohn Co., Kalamazoo, Mich., Pittsburgh Plate Glass Co., Pittsburgh, Pa., Eli Lilly & Co., Greenfield, Ind., and R. T. Vanderbilt Co., Inc., New York, N.Y., who provided some of the chemicals.

Trade names are used in this publication solely for the purpose of providing specific information. Mention of the trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

SUMMARY

Six treatments were compared for decay control of harvested sweetpotatoes; all satisfactorily controlled soft rot. Improvements in the treatment recommended in earlier reports were compared with other treatments that might be more effective and easier to use, would eliminate or reduce chemical residues, or would be less toxic to the sweetpotatoes. Three ways of reducing decay were tried: Modification of the chemical treatment (SOPP, sodium o-phenylphenate tetrahydrate) that is used by many shippers, evaluating other chemical and warm-water treatments, and improving packing and loading methods.

One chemical, assigned an experimental label, proved simpler to use, cheaper, and less likely to cause discoloration of the roots than SOPP.

Treated roots shipped in corrugated boxes developed less decay than comparable roots shipped in bushel baskets. Paper bushel-basket liners did not protect treated roots that were in contact with the lid and rim; proportionately more soft rot developed in the top layer of roots. Using a standard excelsior lid cushion in the baskets reduced decay about 50 percent.

Nearly all sweetpotatoes are shipped to market by truck. Air circulation and temperature are not problems when roots are shipped in bushel baskets; corrugated cartons must be stacked to allow air to circulate through the load. Floor racks aid air circulation in carton loads. An alternately offset load pattern was developed that permitted air circulation through the load and so maintained reasonably uniform temperatures.

FUNGICIDAL TREATMENTS AND SHIPPING PRACTICES FOR CONTROLLING DECAY OF SWEETPOTATOES DURING MARKETING

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BACKGROUND

As a result of previous research (*9*),[1] many sweetpotatoes shipped to market are treated with sodium o-phenylphenate tetrahydrate (SOPP) to control decay, particularly soft rot, during marketing. Reduction of decay through use of SOPP has encouraged consumer packaging (*12*) and the use of corrugated paper shipping containers. To avoid chemical injury and yet control decay, the concentration of SOPP must be carefully maintained at 0.4 to 0.5 percent for roots that are not cured or that skin easily during grading, and at 0.8 to 1 percent for cured roots that do not skin easily. Treatment is followed with a brief water or wax emulsion rinse to reduce the danger of discoloration or chemical injury of the roots.

The SOPP treatment is usually not applied to freshly dug, noncured roots for two reasons; soft rot is usually not troublesome in the summer or fall during the harvest period (*13*) and some discoloration and chemical injury has been reported after treatment of such roots. Usually this discoloration followed treatments which were not as closely supervised as prescribed, even though a packinghouse procedure for maintaining concentration is available (*10*). Even with careful use of SOPP some discoloration of skinned areas may occasionally result.

The tests reported here were to evaluate possible improvements in the use of SOPP and compare it with other potentially useful treatments which might be more effective and easier to use, would eliminate or reduce chemical residues, or would be less toxic to the sweetpotatoes. Three approaches were used: (1) Modification of the SOPP treatment, (2) evaluation of other treatments, and (3) improvement of in-transit conditions to reduce injury and subsequent decay of the roots.

METHODS

Screening and holding tests were conducted in much the same manner as described in previous reports (*9*, *12*). For evaluation of soft rot, bruised roots were immersed in the appropriate solution for 15 to 30 seconds (unless otherwise indicated), drained, packaged in kraft paper bags, and held at 60° F. for 7 or more days to allow soft rot to develop. For black rot evaluation, inoculum was obtained by mascerating scrapings of root pieces with actively sporulating perithecia in a small amount of water containing a few drops of Tween 20 (polyoxyethylene sorbitan monolaurate). This was added to the appropriate solution, mixed, and root pieces immersed momentarily before holding in culture chambers at 80° F. for 1 week.

Commercial treatments with SOPP and Botran were made in dip tanks or with spray applicators described previously and subject to dilution rates reported (*10*). In a few tests Tween 80 (polyoxyethylene sorbitan monooleate) was used as a wetting agent. For these commercial tests, commercially washed and graded roots were treated without purposely inflicting injury.

Shipping tests were made with bushel baskets and corrugated boxes to determine their influence upon the development of decay and air circulation in the load. Temperatures in transit were obtained with recording thermometers placed in the center of shipping containers. Outside temperatures were obtained with a recording thermometer attached underneath the truck trailer.

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[1] Italic numbers in parentheses refer to literature cited, page 12.

RESULTS

Modification of the SOPP Formulation

One manner of avoiding injury and discoloration with SOPP treatment commonly employed is that of modifying the formulation of the SOPP treating solution. The most widely used methods of modification were tried previously (*9*). Solubilizing o-phenylphenol (OPP) in the sodium salt of dodecylated oxydibenzene disulfonate (DDOS), as recently reported by Mallmann and Butt (*15*), as well as emulsifying OPP after dissolving it in a small amount of DDOS or corn oil was tried. Solubilizing OPP in DDOS did not reduce the chemical injury or discoloration obtained with equivalent concentrations of SOPP in water, but the emulsions produced less discoloration and chemical injury without reducing its effectiveness in controlling soft rot (table 1).

Control of decay at lower concentrations of SOPP and OPP, which ordinarily do not give good control of decay but do not injure the roots, was increased by increasing the acidity of the treating solution (table 2). This did not increase effectiveness enough to provide a desired level of decay control, however, and acid solutions would corrode most equipment.

These data indicate a stable emulsion concentrate of OPP that can be diluted to working concentration and be less injurious to the roots than present formulations may be practical as with citrus (*21*). However, a method of maintaining concentration during use must be developed because presently used techniques are not appropriate for such formulations. Such a formulation would probably need to be used conservatively because of the higher cost of producing such an emulsion.

Table 2.—*Effect of pH and solutions of SOPP and OPP on development of soft rot in bruised Goldrush sweetpotatoes*

[Roots bruised, immersed 30 seconds in treating solutions, drained, and without rinsing packaged in perforated polyethylene bags, then held 7 days at 60° F. before examination. No chemical injury or discoloration noted. Acidity adjusted with dilute HCl. Values based on 40 roots per treatment]

Amount of active ingredient	Solvent	Concentration of treating solution	Soft rot at bruises
Gm./gal.	*Ml./gal.*	*pH*	*Pct.*
9.5 SOPP [1]	Water	10.5	28
4.75 SOPP [2]	do	10.4	38
6.3 OPP [1]	35.0 DDOS [3]	2.4	10
3.15 OPP [2]	17.5 DDOS	2.4	28
6.3 OPP [1]	35.0 DDOS [3]	8.6	15
3.15 OPP [2]	17.5 DDOS	8.4	40
None (water)		6.7	94
L.S.D. (least significant difference) at 5-percent level			12

[1] Equivalent to 0.25 percent SOPP in o-phenylphenol content.

[2] Equivalent to 0.125 percent SOPP in o-phenylphenol content.

[3] Sodium salt of dodecylated oxydibenzene disulfonate.

Table 1.—*Effect of solutions of SOPP and OPP and emulsions of OPP on development of soft rot, discoloration, and chemical injury in bruised Goldrush sweetpotatoes*

[Roots bruised, immersed 30 seconds in treating solution, drained, and packaged without rinsing in perforated polyethylene bags, then held 7 days at 60° F. before examination. Values are based on 40 roots per treatment]

Amount of active ingredient	Solvent	Emulsifier	Concentration of treating solution	Soft rot at bruises	Discoloration	Chemical injury
Gms./gal.	*Ml./gal.*	*Ml./gal.*	*pH*	*Pct.*		
None (water)			6.7	38	Very slight	None.
38.0 SOPP [1]	Water	None	10.7	0	Severe	Severe.
19.0 SOPP [2]	do	do	10.9	0	Moderate	Slight.
25.0 OPP [1]	125 DDOS [3]	do	[4] 6.5	0	Severe	Severe.
12.5 OPP [2]	63 DDOS	do	[4] 6.5	0	Moderate	Moderate.
25.0 OPP [1]	25 DDOS	50 Tween 80 [5]	6.5	0	Very slight	None.
12.5 OPP [2]	13 DDOS	25 Tween 80 [5]	6.5	0	do	Do.
25.0 OPP [1]	75 Corn oil	8 Tween 80	6.5	0	do	Do.
12.5 OPP [2]	38 Corn oil	4 Tween 80	6.5	0	do	Do.

[1] Equivalent to 1-percent SOPP in o-phenylphenol content.

[2] Equivalent to 0.5-percent SOPP in o-phenylphenol content.

[3] Sodium salt of dodecylated oxydibenzene disulfonate.

[4] Adjusted to pH 6.5 with sulfuric acid.

[5] Warmed to liquefy the OPP before blending to emulsify. Tween 80 is polyoxyethylene sorbitan monooleate.

Other Decay Control Treatments

Warm water.—The sensitivity of black rot to heat has been established (*9*, *11*). There is also some indication that Rhizopus soft rot of sweetpotatoes could be reduced with warm-water treatments (*9*). Smith (*20*) showed that warm-water treatments reduced Rhizopus decay of peaches.

To evaluate the effectiveness of warm water in the control of soft rot, injured sweetpotato roots were immersed in water for 1, 3, or 5 minutes at temperatures ranging from 110° to 140° F. (table 3). Dipping the injured roots for 1 to 5 minutes in 110°–120° water, or 1 to 3 minutes in 130°–140° water reduced soft rot. Treatment in 130° water or above even for 1 minute caused some discoloration or darkening of tissue below the skin. Treatment for 5 minutes in 130° water did not reduce soft rot and 5 minutes in 140° water increased soft rot, apparently as a result of injury.

To determine more accurately the minimum time and temperature that may be used to reduce soft rot, injured roots were treated at 115°, 120°, and 125° F. for various periods of time (table 4). Although all treatments reduced soft rot, control increased with time and temperature within the limits of the test.

TABLE 3.—*Effect of immersing bruised sweetpotatoes for 1 to 5 minutes in water at 110° to 140° F. upon development of soft rot and discoloration*

[Roots bruised, immersed in hot water, drained, packaged in perforated polyethylene bags, and held 14 days at 60° F. before examination]

Water temperature	Immersion period	Soft rot at bruises [1]	Tissue discoloration [2]	
			Goldrush	Seedling [3]
° F.	*Min.*	*Pct.*		
70	5	30	None	Very slight.
110	1	10	do	Do.
	3	10	do	Do.
	5	3	do	Slight.
120	1	8	do	Do.
	3	5	do	Do.
	5	5	do	Moderate.
130	1	5	Very slight.	Slight.
	3	5	Slight	Moderate.
	5	24	Moderate	Severe.
140	1	5	Very slight.	Moderate.
	3	20	Moderate	Severe.
	5	75	Severe	Very severe.
L.S.D. at 5-percent level		8		

TABLE 4.—*Effect of immersing bruised Centennial sweetpotatoes for 15 to 120 seconds in water at 115° to 125° F. upon development of soft rot*

[Roots bruised, immersed in hot water, drained, packaged in kraft paper bags, and held 14 days at 60° F. before examination. 5 replicates of 20 roots each]

Water temperature	Immersion period	Soft rot at bruises
° F.	*Sec.*	*Pct.*
70	15	35
115	15	18
	30	13
	60	15
	120	12
120	15	21
	30	18
	60	10
	120	3
125	15	14
	30	12
	60	4
	120	6
L.S.D. at 5-percent level		8

These data indicate a treatment of 2 to 3 minutes in water at 120° or 125° F. may give a practical and useful reduction of soft rot without damaging the roots. Such a treatment is compared with others later in this report.

Warm SOPP solutions.—Previous tests (*9*) showed that solutions of SOPP more dilute than 0.4 to 0.5 percent did not control decay as well as concentrations above this unless the temperature of the treating solution was elevated. The required 2- to 3-minute treating time with 120°–125° F. water requires sufficient warm water and special equipment to process 200 or 300 bushels per hour. After preliminary tests it was determined that treating time could be reduced to 15 seconds by adding up to 0.2 percent SOPP to warm (120° F.) water (table 5). This treatment also is compared with others later in this report.

Other chemical treatments.—In the continuing search for more satisfactory chemicals, several materials were screened for control of soft rot (table 6). Five of these showed promise in reducing soft rot: 2, 6-dichloro-4-nitroaniline, or Botran, for which other workers report fungicidal value (*3*, *4*, *17*, *18*); propynyl-N-phenylcarbamate, reported previously to be effective (*10*); propynly-N-3-chlorophenylcarbamate; alpha-carbo (2, 4-dichlorophenoxyethyl) ethyl-N-phenylcarbamate; and Vancide 51, a mixture of sodium salts of dimethyldithiol carbamic acid and 2-mercaptobenzothiozole for which Aycock (*2*) reports some reduction of soft rot of sweetpotatoes. Of these five materials, Botran and Vancide 51 were ineffective in controlling black rot in additional screening tests (table 7). None of these five chemicals caused discoloration or injury within the ranges

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[1] Average of 2 tests each with 40 roots per treatment for each variety.

[2] Darkening of tissue below the skin.

[3] With Nugget as one parent.

TABLE 5.—*Reduction of soft rot in bruised Goldrush sweetpotatoes when immersed in water at 120 F. with and without the addition of SOPP*

[Roots bruised, immersed in treating solution, drained, packaged in kraft paper bags, and held 7 days at 60° F. before examination. 5 replicates of 20 roots each]

Treating solution	Temperature	Immersion period	Soft rot at bruises
	° F.	*Sec.*	*Pct.*
Water	70	15	79
Do	120	15	70
0.1% SOPP	120	15	25
0.2% SOPP	120	15	14
Water	120	180	12
L.S.D. at 5-percent level.			10

tested although some bleaching may have occurred with Vancide 51 at concentrations above 2 percent.

Vancide 51 is recommended for disinfecting grading equipment for control of black rot and reduction of soft rot (*16*). Although Vancide 51 is approved for use on seed roots, it has not been approved for treating roots to be used for food. Additional work is needed to determine why Vancide 51 was ineffective in the test reported here for controlling black rot.

Comparisons of promising treatments.—Treatments offering the greatest promise of successful commercial application were tested on a larger scale. A 30-second dip treatment in

TABLE 7.—*Growth of black rot on freshly cut surfaces of Goldrush sweetpotatoes immersed in solutions of different concentrations of four chemicals containing black rot inoculum*

[Values based on 4 root pieces for each chemical and concentration after holding 7 days at 80° F.]

Chemical [1]	Percentage of surface covered with mold growth at concentration of—						
	0	0.063	0.125	0.25	0.5	1.0	2.0
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Botran	87	90	80	70	62	45	----
PPC	90	8	10	5	----	----	----
PCC	100	25	10	20	----	----	----
ACDPC	100	10	0	0	----	----	----
V51	100	----	----	----	100	90	80

[1] Identification of the chemicals is given with table 6.

TABLE 6.—*Percentage of soft rot in bruised Goldrush sweetpotatoes treated with different concentrations of 12 chemicals*

[Values based on 40 roots for each chemical and each concentration. Treated by immersing 15 to 30 seconds in treating solutions. Roots held 7 days at 60° F. before examined]

Chemical	Soft rot in bruised root ends at concentration of—									
	0	0. 016	0. 031	0. 063	0. 125	0. 25	0. 5	1. 0	2. 0	4. 0
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
SP	38	--------	--------	--------	--------	55	63	60	65	--------
Botran	63	3	0	1	0	0	0	0	--------	--------
PPC	80	--------	10	3	0	0	0	0	--------	--------
PCC	63	--------	--------	30	8	8	0	--------	0	--------
ACDPC	58	--------	--------	80	73	35	0	--------	0	--------
ACDCC	100	--------	--------	--------	97	--------	95	--------	75	--------
BDPC	65	--------	--------	--------	35	--------	62	--------	65	--------
BDCC	92	--------	--------	--------	50	--------	55	--------	78	--------
V51	100	--------	--------	--------	--------	--------	--------	67	35	0
NACAP	90	--------	--------	--------	--------	--------	--------	85	73	28
2AB–1	90	--------	--------	--------	95	--------	--------	100	100	--------
2AB–2	70	--------	--------	--------	80	--------	--------	70	80	--------

The symbols stand for the following chemicals:

SP is sodium propionate;
Botran is 2,6 dichloro-4-nitroaniline;
PPC is propynyl-N-phenylcarbamate;
PCC is propynyl 1-N-3-chlorophenylcarbamate;
ACDPC is alpha-carbo (2,4-dichlorophenoxyethyl) ethyl N-phenylcarbamate;
ACDCC is alpho-carbo (2,4-dichlorophenoxyethyl) ethyl N-3 chlorophenylcarbamate;
BDPC is B-2,4-dichlorophenoxyethyl N-phenylcarbamate;
BDCC is B-2,4-dichlorophenoxyethyl N-3 chlorophenyl carbamate;
V51 is a proprietary mixture containing 27.6-percent sodium dimethyldithiol carbamic acid and 2.4 percent sodium 2, mercaptobenzothiozole, or Vancide 51;
NACAP is a proprietary mixture containing 50-percent sodium 2, mercaptobenzothiozole;
2AB–1 is 2 aminobutane bicarbonate;
2AB–2 is 2 aminobutane acetate.

The carbamates PPC, PCC, ACDPC, ACDCC, BDPC, and BDCC were supplied as emulsions fairly stable in water. Percentages are based on active ingredient in the final mixture on a weight-for-weight basis except V51, which was used on a volume-for-volume basis, so that the percentage given is a percentage of V51 rather than of the active ingredient.

1-percent SOPP or 0.2-percent Botran, or a 3-minute dip in 120° F. water were equally effective in control of soft rot of commercially washed and graded Jersey Orange sweetpotatoes (table 8). None of the treatments significantly affected the development of other rots. Roots treated with Botran and hot water lost less weight than nontreated roots, probably because of a difference in weight lost from decaying roots. The differences in weight loss and shriveled roots are comparable with those reported earlier for the types of containers used (*12*).

Table 8.—*Effect of different treatments and containers upon weight loss, shriveling, and decay of Jersey Orange sweetpotatoes*

[Roots washed and graded commercially at Egg Harbor, N.J.; treated, packaged, and transported to Beltsville, Md., then held 1 week at 60° F. and displayed 1 week]

Treatment and container [1]	Weight loss	Shriveled roots	Soft rot	Other rots
Control (no treatment):	*Pct.*	*Pct.*[2]	*Pct.*[2]	*Pct.*[2]
½-bushel basket	11.2	4	6	3
3-lb. polymesh bag	10.9	7	16	3
3-lb. polyethylene bag	3.8	0	13	5
Average	8.6	3.7	11.7	3.7
1-percent SOPP:				
½-bushel basket	9.5	12	1	5
3-lb. polymesh bag	10.9	17	1	7
3-lb. polyethylene bag	3.4	1	2	6
Average	7.9	10.0	1.3	6.0
0.2-percent Botran:				
½-bushel basket	8.1	7	3	1
3-lb. polymesh bag	9.3	5	1	3
3-lb. polyethylene bag	3.5	1	0	8
Average	7.0	4.3	1.3	4.0
Hot water, 120° F. 3 min.:				
½-bushel basket	9.1	11	4	3
3-lb. polymesh bag	9.1	6	1	7
3-lb. polyethylene bag	3.5	1	4	6
Average	7.2	6.0	3.0	5.3
Mean, all treatments:				
½-bushel basket	9.5	8.5	3.5	3.0
3-lb. polymesh bag	10.1	8.8	4.8	5.0
3-lb. polyethylene bag	3.6	.8	4.5	6.3
L.S.D. at 5 percent for difference between:				
Treatment means	1.2	N.S.	6.2	N.S.
Container means	1.0	5.7	N.S.	N.S.

[1] 0.1-percent Tween 20 used as a wetting agent with SOPP (Sodium 0-phenylphenate tetrahydrate) and Botran (2,6-dichloro-4-nitroaniline). The roots in the polymesh bags were treated by dipping the bags. Polyethylene bags had 32 ¼-inch perforations. Sixteen 3-pound bags per treatment were held in a master carton for 1 week at 60° F. then removed and placed 2 deep on a counter at 70° F. for 1 week.

[2] Based on number of roots.

In a similar test with Goldrush sweetpotatoes packaged in perforated polyethylene bags, immersion of commercially washed and graded roots for 15 to 30 seconds in 0.25 percent propynyl-N-phenyl-carbamate was compared with 1-percent isopropyl N-(3 chlorophenyl) carbamate (*9*) and 1-percent SOPP. All three treatments significantly reduced the development of soft rot, did not affect other rots, and were not significantly different from each other in development of soft rot (table 9). Both carbamates inhibited sprouting of the roots, but SOPP did not. Microscopic examination of slices of sweetpotatoes treated with both carbamates showed they inhibited periderm formation and produced cellular transformations similar to those reported for Irish potatoes (*1*) at these concentrations as well as much lower concentrations.

A residue tolerance of 5 p.p.m. has been established by the Food and Drug Administration for

TABLE 9.—*Effect of different chemical treatments upon development of decay and sprouting of commercially washed and graded Goldrush sweetpotatoes packaged in polyethylene bags*

[Values are based on eight 3-pound bags per treatment, held 1 week at 60° F. and 3 weeks at 70°, with a relative humidity of 75 to 85 percent. Bags were perforated with 32 ¼-inch holes]

Treatment	Soft rot	Other rots	Roots with sprouts over ¾ inch long
	Pct.	*Pct.*	*Pct.*
Untreated (control)	11	2	33
1.0 percent CIPC [1] dip	2	2	3
0.25 percent PPC [1] dip	1	1	4
1.0 percent SOPP [1] dip, then rinsed	1	3	28
L.S.D. at 5-percent level	3	N.S.	8

[1] CIPC is isopropyl-N-(3-chlorophenyl) carbamate; PPC is propynyl-N-phenylcarbamate; and SOPP is sodium o-phenylphenate tetrahydrate.

Botran on sweetpotatoes going into marketing channels under an experimental label. Tests, employing Botran with commercial equipment, were made to compare its effectiveness with the present commercial SOPP treatment and a warm-water treatment or warm SOPP treatment.

Centennial sweetpotatoes treated commercially in a dip tank with SOPP or Botran during the customary washing and grading practices in two packinghouses were compared with roots treated by hand with warm water, warm 0.2-percent SOPP, or not treated (table 10). Botran and warm 0.2-percent SOPP solutions controlled soft rot as well as the standard SOPP treatment or better. Botran was equally effective when the tank was first charged (800–1,000 p.p.m.), with or without an application of wax afterward, or after treating over 1,000 bushels without adding additional Botran (500 to 600 p.p.m.). Treatment with warm water reduced soft rot but less than other treatments did. Although a small amount of Fusarium rot developed on roots in all treatments, no black rot developed. Weight losses in transit varied between tests but not consistently between treatments.

Two supplementary tests conducted at shipping point with Botran sprayed on roots produced similar results. Dilution of the Botran was rapid in the small spray tank reservoir (15-gallon capacity), as noted for SOPP (*10*), and frequent additions were required to maintain the concentration at levels satisfactory for controlling soft rot.

Improvement of In-Transit Conditions To Reduce Injury and Infection of Roots After Treatment

Containers.—In holding studies it was found that the recommended SOPP treatment of commerically washed and graded roots usually reduced soft rot by about 90 percent (table 8). In shipping tests with commercially treated roots, results were not as good; this was due, in part at least, to injuries the roots received after they were treated. Roots shipped in bushel baskets developed proportionately more decay in the area where roots came in contact with the basket than where they did not, especially those in contact with

TABLE 10.—*Effect of treating Centennial sweetpotatoes with SOPP, Botran, and warm water upon weight loss in transit and development of soft rot in the market*

[Shipped in November from Wilson, N.C., to Chicago, Ill. Transit temperature varied from 57° to 63° F. Data based on three 50-pound corrugated cartons of roots per treatment per test]

Treatment	Weight loss in transit[1]		Soft rot after 14 days in the market[2]	
	Test 1	Test 2	Test 1	Test 2
	Pct.	*Pct.*	*Pct.*	*Pct.*
Nontreated control	3.1	1.1	39	16
SOPP, 0.8 to 1.0 percent rinsed[3]	3.2	1.1	4	5
Botran, 800 to 1,000 p.p.m., not rinsed	3.4	1.2	6	1
Botran, 800 to 1,000 p.p.m., rinsed[4]	3.4	1.0	5	2
Botran, 500 to 600 p.p.m.,[5] rinsed[6]	2.9	1.0	2	1
Water, 120–125° F., 3 minutes[7]	4.6	.6	15	10
SOPP, 0.2 percent, 120–125° F., 15 sec.[7]	2.8	1.0	3	1

[1] Based on weight at shipping point.

[2] Roots held 7 days at 60° F., examined, held 7 more days at 70° F., and reexamined.

[3] Water in test 1, clear water-wax in test 2.

[4] Clear water-wax in both tests, freshly prepared.

[5] After treating 1,000 to 1,100 bushels with same treating solution.

[6] Clear water-wax in test 1; colored (certified food color Ponceaux Sx) water-wax in test 2. Used during grading and containing up to 350 p.p.m. of Botran.

[7] Application made by hand in a small electrically heated tank containing 20 gallons of treating solution. Temperature raised to 125° F. and not allowed to drop below 120° F. after addition of roots.

TABLE 11.—*Development of soft rot in commercially washed, graded, and SOPP-treated Nugget and Goldrush sweetpotatoes*

[Shipped in bushel baskets from North Carolina to New York, N.Y., or Chicago, Ill., 1962 season. Each figure based on four baskets, two each in top and bottom layers of the load. Each basket was lined with one strip of paper (13 by 55 inches) folded down into the basket under and then over the roots. Examination made after holding at 60° or 70° F. for 1 week in the market]

Treatment and shipment number	Percentage of roots developing soft rot at—			
	Lid and rim	Sides and bottom	Center	All roots
Nontreated roots:				
1	29. 6	14. 7	9. 2	15. 0
2	41. 5	14. 0	11. 5	16. 8
3	18. 7	4. 5	4. 3	6. 5
4	4. 0	2. 6	3. 9	3. 5
Average	23. 4	8. 9	7. 2	10. 4
Treated roots:				
1	10. 0	5. 1	2. 7	4. 8
2	9. 3	3. 0	1. 9	3. 7
3	11. 6	. 0	0. 8	2. 1
4	5. 2	. 6	. 0	1. 2
Average	9. 0	2. 2	1. 4	2. 9

TABLE 12.—*The development of soft rot in commercially washed, graded, and SOPP-treated Goldrush roots*

[Shipped in bushel baskets from North Carolina to New York, N.Y., with and without treated lids and lid cushions. Each figure based on four baskets, two each in top and bottom layers of the load. Each basket was lined with one strip of paper (13 by 55 inches) folded down into the basket under and then over the roots. Examination made after holding at 70° F. for 1 week in the market]

Treatment and shipment number	Percentage of roots developing soft rot at—			
	Lid and rim	Sides and bottom	Center	All roots
Nontreated control:				
1	14. 1	1. 0	0. 0	3. 2
2	11. 2	5. 8	3. 1	5. 9
Average	12. 6	3. 4	1. 5	4. 5
Treated lid:				
1	7. 4	1. 5	. 0	2. 0
2	7. 9	6. 4	3. 0	5. 4
Average	7. 6	3. 9	1. 5	3. 7
Lid cushion:				
1	4. 1	. 0	. 0	. 7
2	6. 1	2. 5	. 5	2. 3
Average	5. 1	1. 2	. 2	1. 5

the lid and rim (table 11). In these tests the baskets were lined with a single strip of paper (13 by 55 inches) which was folded down into the basket under the roots and over the top of the sweetpotatoes as is customary along the eastern seaboard. Although this provides some protection for the roots, apparently it was not enough.

Treating the lids by briefly immersing them in 1-percent SOPP solution or using a standard excelsior lid cushion reduced the development of decay in the lid and rim area approximately 50 percent (table 12). Several other lid cushions (fig. 1) and basket liners were tried but none gave significantly better results than the standard excelsior lid cushion and data are not shown.

Some packinghouses that began to use SOPP also began to ship some roots in corrugated cardboard boxes, partly because the reduction of soft rot permitted using such a container, partly because receivers requested a container that could be easily shipped on pallets, and partly because of the reduced cost. Wirebound crates or tub-bottom bushel baskets cost 45 cents or more each; the corrugated cardboard container costs at least 10 to 12 cents less, including the cost of stapling. Less decay developed in corrugated cardboard boxes than in bushel baskets, presumably because the roots were injured less in the boxes (table 13). Although the corrugated cardboard boxes used were relatively tight, they were not made of waterproofed board and weight losses were similar to those found in bushel baskets. Slightly more decay developed in the top of the boxes than in the center, but the difference was not significant.

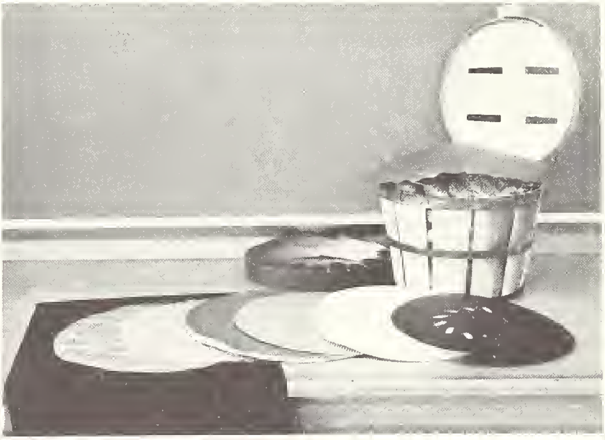

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FIGURE 1.—Lid cushions and fringe tested to reduce injury and subsequent development of soft rot of sweetpotatoes. From left to right on the table, polyethylene with air bubbles (2 sizes), pressed cotton with kraft paper backing, single-c-flute corrugated cardboard, urethane foam rubber, an insert of pressed paper pulp, and standard excelsior filled cushion on the basket.

TABLE 13.—*Development of soft rot in Centennial sweetpotatoes shipped in December from North Carolina to Chicago, Ill., in corrugated cardboard boxes and tub-bottom bushel baskets*

[All roots commercially treated with a weak SOPP solution estimated at approximately 0.3 to 0.4 percent. Data are based on three bushel baskets for each treatment and test after holding 8 days at 60° F. in the market]

Shipping container	Soft rot percent by weight		Weight loss in transit		Weight loss during holding	
	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Corrugated cardboard, 50 lb. net[1]	5.0	6.2	1.4	1.9	3.3	2.6
Bushel basket, tub bottom with liner and lid cushion	9.2	7.3	1.8	1.8	2.7	4.9
Bushel basket, tub bottom with two paper strips[2]	19.6	8.2	2.5	2.2	3.2	3.7

[1] 275-pound-test bottom, 200-pound-test top, full telescope.

[2] Standard 13-by-55-inch paper strips folded down into the basket under the roots and then over the top.

Shipping.—Nearly all sweetpotatoes are shipped to market in truck trailers. Ventilation and air circulation of loads composed of bushel baskets customarily used in the eastern United States has not been a problem because of the opportunity for air movement around and, to some extent, through the baskets. For corrugated boxes, however, which can be stacked solidly in a load, it is desirable to develop a loading pattern providing good air circulation around the load, especially during the winter when heat would be required to prevent chilling or freezing of the sweetpotatoes (*8*). Hruschka and others (*7*), in their studies with truck transportation of Irish potatoes requiring protection from low temperatures, demonstrated the need for adequate air circulation and pointed out that trailer construction lacks uniformity and protective services are not available. Redit (*19*) summarized the problem as "* * * more open loads, adequate floor racks and wall strips, a ceiling duct to direct the * * * air to the rear of the vehicle, adequate space for air to move between the load and rear doors, and—probably of greatest importance—a proper return-air duct that will channel all the return air from the floor of the trailer back to the unit." This is probably meant to include air moving horizontally through the load being able to reach such a return-air duct or bunker opening too.

Temperatures recorded in the front and rear quarterlength positions of a load with reasonably good provision for air circulation (load 1, table 14) and one with very little provision for air circulation (load 2, table 14) verified the need for good air circulation in loads of corrugated cartons. With good air circulation temperatures varied up to 6° F. throughout the load, but with inadequate circulation, temperatures varied up to 21° and at some positions temperatures were 40° or below, low enough to cause chilling injury to the roots (*14*). However, no chilling injury was detected in this test probably because the roots were at these low temperatures for too short a time. Additional chilling after arrival at the market would add to the injury with roots already chilled for several hours in transit.

The chimney-type stack used with load 1 tied the load together fairly well, but was difficult to stack because of a tendency for the package to bulge. This type of stack was difficult to count or verify a count after loading, and was not sufficiently flexible in width to readily fit the many widths of trailers. Many trucks that haul sweetpotatoes do not have floor racks and a chimney-type stack is not practical. For these reasons an alternately offset pattern was tried in which the air channels were maintained along the sidewalls and a special stacking arrangement in the stack next to the bunker permitted the air moving along the sidewalls to return to the bunker opening on the floor (figs. 2 and 3). This pattern was easy to load and check and provided more stability than the chimney stacking pattern. It was also easy to adjust to the different inside widths of trailers.

With this load, temperatures were not as uniform as in bushel basket loads (table 15). With mechanical equipment and 3 to 4 inches of insulation a variation of 7° F. developed with cartons in different positions, while a temperature variation of 3° to 4° developed in a comparable load of bushel baskets. When charcoal heaters were used for heating a load of cartons in a trailer with 1½ to 2 inches of insulation, a variation in temperature of 15° developed, primarily because the heated air could not circulate freely to the front of the trailer because the 1-inch floor channels are too small.

Because the temperatures in the carton loads departed most from the desired transit temperature of 55° to 60° F. in the bottom of the load, especially next to the sidewall, one apparent need is floor racks that allow adequate circulation under the loads. This lack of circulation is not easily compensated for by loading patterns.

Table 14.—*Temperature changes in 2 heated loads of sweetpotatoes shipped in December from North Carolina to Chicago, Ill., in corrugated cartons during cold weather with and without provision for air circulation around the load*

[Both shipments were made in vans containing 1½ to 2 inches of insulation in walls and ceiling with charcoal pots placed at rear of the load for heat. These shipments traveled together in transit]

Load No. and positions of thermometers in truck and in load	Temperatures (° F.) after indicated hours in transit						
	0	12	24	36	48	60	72
Load No. 1 [1]							
Front quarter of truck:							
Top of load at center	55	49	50	50	50	48	49
Bottom at side	54	49	52	52	51	51	51
Rear quarter of truck:							
Top of load at center	59	55	54	54	54	54	55
Center of stack	54	53	52	53	54	54	54
Bottom at center	55	51	50	51	52	53	54
Bottom at side	56	51	52	52	52	53	53
Load No. 2 [2]							
Front quarter of truck:							
Top of load at center	50	41	40	40	40	39	38
Bottom at side	52	44	44	43	42	41	40
Rear quarter of truck:							
Top of load at center	54	54	55	53	54	54	54
Center of stack	54	54	55	56	57	58	59
Bottom at center	55	53	50	51	50	51	51
Bottom at side	50	46	47	46	46	45	46
Outside air:							
Maximum during preceding 24 hours	--------	--------	42	--------	40	--------	46
Minimum during preceding 24 hours	--------	--------	13	--------	24	--------	22

[1] Cartons were placed in chimney stacks to maintain 2- to 4-inch space along each sidewall except for top layer, which was made solid from wall to wall by turning one row of cartons crosswise and leaving all others lengthwise. Floor racks with about 2 inches of clearance were used. Bunker blower circulated heated air under and along the sides of the load, up through the bunker, and back over the load.

[2] Cartons were placed lengthwise in an alternately offset pattern against sidewalls, but no air channels were maintained. Floor made of 1-inch aluminum channels. Bunker blower operated during transit period.

DISCUSSION

Treating sweetpotatoes with SOPP as well as reducing contamination on grading equipment has substantially reduced losses during marketing. However, some benefits of treating to reduce decay are nullified by injuries inflicted during wholesale and retail handling and by damage caused by bushel baskets during transit.

The desirability of reducing injuries to fruits and vegetables that are packed in tub-bottom bushel baskets is widely known. Lid cushions and liners are usually recommended for commodities shipped in bushel baskets (*5*, *6*). Because soft rot is more common during winter than during fall (*13*), lid cushions would probably reduce damage in sweetpotatoes shipped in bushel baskets during the winter. However, lid cushions should supplement good packaging and handling practices, because no amount of cushioning could protect roots from careless packaging and rough handling.

Corrugated boxes, in addition to reducing damage and subsequent decay, have the space-conserving advantage of other rectangular containers. Trucks loaded with bushel baskets often cannot be loaded with as many baskets as their axle and weight limitations permit. With the corrugated box, as well as wirebound crates used for shipping sweetpotatoes, 20 or 25 percent more payload is usually possible if space is a limiting factor. This reduces the transportation cost per package.

The corrugated boxes used in these tests weighed about 2.3 pounds or 2 to 3 pounds less than the tub-bottom bushel or wirebound crate. This means 1,000 to 1,500 pounds more payload in a trailer hauling 500 shipping containers. The corrugated box does not damage hands or clothes as much as the baskets do because there are no splinters, nails, wires, or rough edges; it does not require a paper liner or lid cushion. Printing on the lid replaces the label usually pasted by hand on the wooden containers, and the printing may include statements required for treatments applied or quality. However, the corrugated box, while

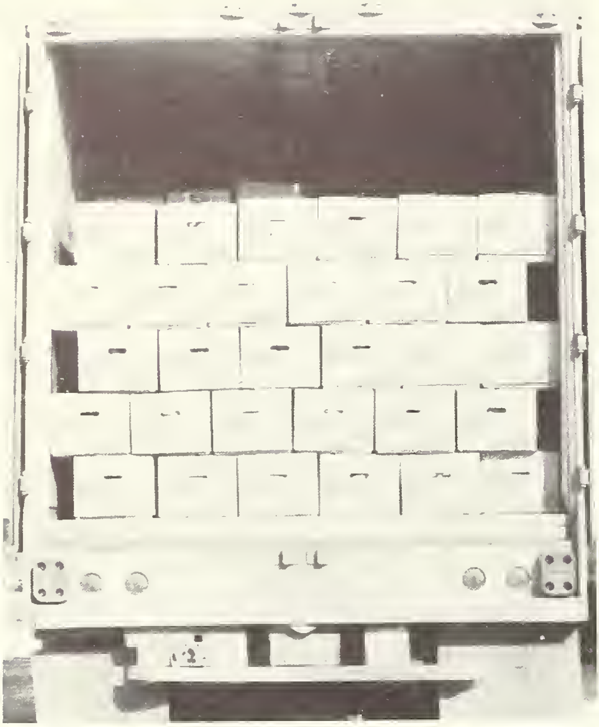

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FIGURE 2.—Offset loading pattern of 50-pound corrugated cardboard boxes. Air channels along sidewalls are maintained to the front of the load. One-inch floor channels (not visible) allow some air movement under the load.

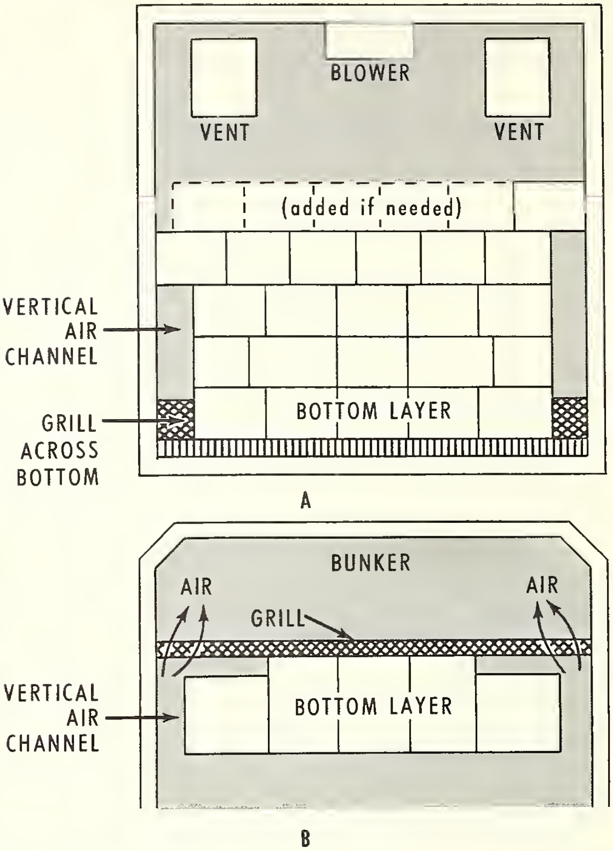

FIGURE 3.—Arrangement of bunker stack of 50-pound corrugated cardboard boxes to allow air moving horizontally along sidewalls (fig. 2) to move vertically down to the bottom bunker opening. At least 22 boxes (5+5+5+6+1) are needed in the first stack to handle two horizontal air channels on each wall (A). Placement of first 5 boxes in bottom layer is shown in plan view (B).

sturdy enough for stacking 6 high in the trailer trucks or on pallets, does not have sufficient strength for stacking pallet on pallet in terminal warehouses. This is not a problem in warehouses equipped with pallet racks.

Because of the irregular shape of sweetpotatoes, it is difficult to fill containers uniformly and solidly. The use of a vibrator during filling of the containers might help to obtain tight and uniform filling. This should reduce injury to the roots in subsequent handling.

If using Botran on sweetpotatoes to control soft rot during marketing is approved, shippers may expect a number of advantages and possibly some disadvantages compared with SOPP. It will cost an estimated 0.5 cent or less per bushel to treat with Botran compared with 1.5 to 2 cents per bushel with SOPP. Botran is effective against soft rot over a wider range in concentration than SOPP; this would make it easier to use in the packinghouse. Botran has not caused discoloration of skinned areas or injury to any of several varieties of sweetpotatoes to which it was applied, even at rates much higher than those being tested commercially (approximately 900 p.p.m.). It can be applied in dip tanks or as a spray, utilizing the waxing and coloring equipment that is on hand in most packinghouses. Special precautions must be followed to mix the Botran (formula 50W) with water before adding wax or coloring dyes or it will precipitate.

It has been possible to run more than 1,000 bushels of roots through a 200-gallon dip tank of Botran before adjusting the concentration. Using SOPP, adjusting the concentration is recommended after each 150 bushels. The small-volume tanks (15-gallon capacity) used to spray most wax or color solutions on the roots dilute SOPP solutions so rapidly that controlling concentration is very difficult (*10*). With Botran in such tanks, approximately 150 bushels may be treated before additional Botran must be added. There is also much less chance that the Botran will become too weak to control decay, or too strong and cause injury.

Because Botran does not control black rot at the concentration studied in this report, it may permit a buildup of the organism in the treating solution

Table 15.—*Temperature changes in heated loads of sweetpotatoes shipped in December from North Carolina to Chicago, Ill., in corrugated cartons and tub-bottom bushel baskets*

[All shipments were loaded the same day and traveled together to market]

Load No., type of container, and position in truck and in load	Temperature (° F.) after indicated hours in transit				
	0	12	24	36	48
Load No. 1, in Baskets [1]					
Front quarter of truck:					
Top of load at center	53	53	53	55	57
Bottom at side	53	54	55	55	56
Rear quarter of truck:					
Top of load at center	53	53	53	57	57
Center of stack	54	51	53	55	56
Bottom at center	52	52	52	54	55
Bottom at side	53	53	53	53	54
Load No. 2, in Cartons [2]					
Front quarter of truck:					
Top of load at center	55	55	56	57	58
Bottom at side	57	57	56	57	57
Rear quarter of truck:					
Top of load at center	57	57	57	57	57
Center of stack	59	59	60	61	61
Bottom at center	56	57	58	59	60
Bottom at side	57	53	54	53	54
Load No. 3, in Cartons [3]					
Front quarter of truck:					
Top of load at center	61	57	56	56	57
Bottom at side	55	53	50	48	47
Rear quarter of truck:					
Top of load at center	56	58	57	58	59
Center of stack	61	58	58	59	61
Bottom at center	60	60	60	61	62
Bottom at side	60	58	54	53	50
Outside air:					
Maximum during preceding 24 hours	----------	----------	58	----------	61
Minimum during preceding 24 hours	----------	----------	36	----------	41

[1] Baskets were alternately offset in the load. A mechanical unit operated on a heating cycle (15,500 B.t.u. per hour at 60° F. trailer temperature and −20° ambient). There was no duct from blower. The truck had 3 to 4 inches of insulation in walls and ceiling and 1-inch aluminum floor channels.

[2] Cartons were alternately offset against sidewalls to maintain air channels to bunker, and bunker stack was arranged to allow air to enter bunker. A mechanical unit operated on a heating cycle (16,000 B.t.u. per hour rating at 70° F. trailer temperature and −30° ambient), with a duct leading from the blower back over the load. The truck had 3 to 4 inches of insulation in the walls and ceiling and 1-inch aluminum floor channels.

[3] Cartons were loaded as those in footnote 2; a charcoal pot at the rear of the load produced heat. There was no duct from the blower. The truck had 1½ to 2 inches of insulation in walls and ceiling and 1-inch wood floor channels.

and thereby inoculate many roots. It is uncertain how serious this may be. Control of black rot by other means has improved to a point where black rot is seldom found in most areas of sweetpotato production. It will grow but slowly on inoculated sweetpotato roots at temperatures up to about 70° F., and temperatures are seldom conducive to its rapid growth in transit and in the market except in the summer, early fall, or late spring.

Unless a warm-water treatment more effective than 120°–125° F. for 3 minutes is devised, it appears that SOPP or Botran treatments will more satisfactorily control soft rot.

If packaging of sweetpotatoes in moistureproof films and the increased shelf life obtainable with preservative treatments increases the sprouting of sweetpotatoes sufficiently to be objectionable, a CIPC or PPC treatment to control this may be developed.

LITERATURE CITED

(1) AUDIA, W. V., SMITH, W. L., JR., and CRAFT, C. C.
1962. EFFECTS OF ISOPROPYL N-(CHLOROPHENYL) CARBAMATE ON SUBERIN PERIDERM AND DECAY DEVELOPMENT BY KATAHDIN POTATO SLICES. Bot. Gaz. 123: 255–258.

(2) AYCOCK, R.
1955. THE EFFECT OF CERTAIN POST STORAGE TREATMENTS ON SOFT ROT DEVELOPMENT IN SWEETPOTATOES. Plant Dis. Rptr. 39: 409–413.

(3) CAPPELLINI, R. A., and STRETCH, A. W.
1962. CONTROL OF POST HARVEST DECAYS OF PEACHES. Plant Dis. Rptr. 46: 31–33.

(4) CLARK, N. C., and HANNS, A. F.
1961. ANTIFUNGAL ACTIVITY OF SUBSTITUTED NITROANALINES AND RELATED COMPOUNDS. Jour. Sci. Food and Agr. 1: 751–757.

(5) FISHER, D. F.
1951. HANDLING APPLES FROM TREE TO TABLE. U.S. Dept. Agr. Cir. 659, 43 pp., illus.

(6) HALLER, M. H.
1952. HANDLING, TRANSPORTATION, STORAGE, AND MARKETING OF PEACHES: A DIGEST OF RECENT CONTRIBUTIONS TO THE KNOWLEDGE OF PHYSICAL AND BIOLOGICAL PHASES OF THE SUBJECT. U.S. Dept. Agr. Bibliog. Bul. 21, 105 pp., illus.

(7) HRUSCHKA, H. W., HANSEN, J. C., and FINDLEN, H.
1960. PROTECTION OF CHIPPING POTATOES FROM LOW TEMPERATURES DURING TRANSPORTATION BY TRUCK. U.S. Dept. Agr. Mktg. Res. Rpt. 431, 20 pp., illus.

(8) JOHNSON, H. D., and BREAKIRON, P. L.
1956. PROTECTING PERISHABLE FOODS DURING TRANSPORTATION BY TRUCK. U.S. Dept. Agr. Handb. 105, 70 pp., illus.

(9) KUSHMAN, L. J.
1961. FUNGICIDAL CONTROL OF DECAY IN PORTO RICO SWEETPOTATOES DURING MARKETING. U.S. Dept. Agr. AMS–452, 19 pp., illus.

(10) ———
1963. ESTIMATION AND MAINTENANCE OF SODIUM O-PHENYLPHENATE CONCENTRATION IN SWEETPOTATO TREATING SOLUTIONS. U.S. Dept. Agr. AMS–521, 10 pp., illus.

(11) ———, and COOLEY, J. S.
1949. EFFECT OF HEAT ON BLACK ROT AND KEEPING QUALITY OF SWEETPOTATOES. Jour. Agr. Res. 78: 183–190.

(12) KUSHMAN, L. J., HARDENBURG, R. E., and WORTHINGTON, J. T.
1964. CONSUMER PACKAGING AND DECAY CONTROL OF SWEETPOTATOES. U.S. Dept. Agr. Mktg. Res. Rpt. 650, 15 pp., illus.

(13) ———, RAMSEY, G. B., SMITH, M. A., and WRIGHT, T. R.
1952. TEMPERATURE AND QUALITY RECORDS FOR SWEETPOTATO TRUCK SHIPMENTS, 1950–51 SEASON. U.S. Dept. Agr. H.T. & S. Off. Rpt. 254, 4 pp., illus.

(14) LUTZ, J. M., RAMSEY, G. B., and COOLEY, J. S.
1946. RECORDING OF TEMPERATURES SHOWS NEED FOR IMPROVEMENTS. Sweetpotato Jour. 1(4): 4–5.

(15) MALLMANN, W. L., and BUTT, F. J.
1961. TORSITE AND MURELLE DETERGENT DISINFECTANTS—TWO NEW PRODUCTS FOR AGRICULTURAL USES. Down to Earth 17(2): 4–7.

(16) MONTELARO, J., MARTIN, W. J., and KANTACK, E. J.
1961. LOUISIANA SWEETPOTATOES. La. Agr. Expt. Sta. Ext. Pub. 1121, 36 pp., illus.

(17) OGAWA, J. M., LYDA, S. D., and WEBER, D. J.
1961. 2,6-DICHLORO-4-NITROANILINE EFFECTIVE AGAINST RHIZOPUS FRUIT ROT OF SWEET CHERRIES. Plant Dis. Rptr. 45: 636–638.

(18) ———, and UYEMOTO, J. K.
1962. EFFECTIVENESS OF 2,6-DICHLORO-4-NITROANILINE ON DEVELOPMENT OF RHIZOPUS ROT OF PEACH FRUITS AT VARIOUS TEMPERATURES. Phytopathology 52: 23.

(19) REDIT, W. H.
1961. THERMOSTATIC CONTROL OF TEMPERATURES IN REFRIGERATOR CARS AND TRUCKS. Fifth Conf. Transportation of Perishables. Proc. March 28–29, Davis, Calif., pp. 118–130.

(20) SMITH, W. L., Jr.
1962. REDUCTION OF POSTHARVEST BROWN ROT AND RHIZOPUS DECAY OF EASTERN PEACHES WITH HOT WATER. Plant Dis. Rptr. 46: 861–865.

(21) WINSTON, J. R.
1950. HARVESTING AND HANDLING CITRUS FRUITS IN THE GULF STATES. U.S. Dept. Agr. Farmers Bul. 1763, 67 pp., illus.

U.S. GOVERNMENT PRINTING OFFICE: 1965 O—769-001